Section 18 Application – sulfoxaflor (Transform™)
Arkansas Cotton
Submitted by the Arkansas State Plant Board and University of Arkansas
Division of Agriculture

Type of Exemption – Arkansas Section 18; Specific Exemption Request; March 1, 2016
This is an application for a specific exemption to authorize the use of Sulfoxaflor (Transform® WG Insecticide EPA Reg. No. 62719-625) to control tarnished plant bug in cotton. The following information is submitted in the format indicated in the proposed rules for Chapter 1, Title 40 CFR, Part 166.

SECTION 166.20(a) 1: IDENTITY OF CONTACT PERSONS

i. The following are the contact persons responsible for the administration of the emergency exemption:

Contact Persons:

Mr. Terry Walker
Director
Arkansas State Plant Board
P.O. Box 1069
Little Rock, AR 72203
501-225-1598
darryl.little@aspb.ar.gov

Ms. Brandi Reynolds
Assistant Director- Product Registration for Pesticide Division
Arkansas State Plant Board
P.O. Box 1069
Little Rock, AR 72203
501-225-1598
brandi.reynolds@aspb.ar.gov

ii. The following qualified experts are also available to answer questions:

University contact:

Gus Lorenz, Extension Entomologist- IPM Coordinator
University of Arkansas Division of Agriculture
Lonoke Research and Extension Center
Lonoke, AR 72086
Phone: 501-676-3124
Fax: 501-676-7787
Email: glorenz@uaex.edu

Nick Seiter, Extension Entomologist

Assistant Professor
University of Arkansas Division of Agriculture
University of Arkansas
SEREC
PO Box 3508
Monticello, AR 71656
Phone: 870-532-7331
Email: nseiter@uaex.edu

Glenn Studebaker
Professor, Extension Entomologist
Entomology
University of AR, Division of Ag
NE Research and Extension Center, Keiser, AR
Telephone Number: 870-526-2199

E-mail: gstudebaker@uaex.edu

Registrant Representative
Tami Jones-Jefferson
U.S. Regulatory Leader
U.S. Regulatory & Government Affairs – Crop Protection
Dow AgroSciences
9330 Zionsville Road
Indianapolis IN, 46268
Tel: 317.337.3574
Email: tjjonesjefferson@dow.com

Jamey Thomas
US Regulatory Manager
Dow AgroSciences
9330 Zionsville Road
Indianapolis, IN. 46268

Cooperating Agency
University of Arkansas Cooperative Extension Service

SECTION 166.20(a) 2: DESCRIPTION OF PESTICIDE REQUESTED

Common Chemical Name (Active Ingredient): Sulfoxaflor

Brand/Trade Name and EPA Reg. No.: Transform® WG Insecticide, EPA Reg. No. 62719-625 (Attachment 1)
Formulation: Active Ingredient 50%

SECTION 166.20(a) 3: DESCRIPTION OF PROPOSED USE

i. Sites to be treated:

The insecticide will be restricted to use on cotton fields in the state of Arkansas for the purpose of controlling the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois).

Historically, cotton has been produced in the counties of:
Clay, Greene, Craighead, Mississippi, Crittenden, St. Francis, Jackson, Prairie, Monroe, Phillips, Lonoke, Pulaski, Jefferson, Lincoln, Drew, Desha, Ashley, Lafayette, Lee, and Chicot in Arkansas.(2000 Crop Profile for Cotton in Arkansas; http://www.ipmcenters.org/cropprofiles/docs/ARcotton.html.)

ii. Method of Application:

Applications will be made by foliar application.

iii. Rate of Application:

1.5 – 2.25 oz/ac (0.047 – 0.0071 lb ai/ac). Annual use will not exceed 8.5 oz. of Transform (0.266 lb. ai/ac).

iv. The maximum number of applications:

Do not apply more than four applications per season.

v. The total acreage to be treated:

In 2015 Arkansas planted approximately 205,000 acres of cotton (http://www.cotton.org/econ/cropinfo/varieties/midsouth.cfmacross). Arkansas producers treated 100% of the total planted acreage for the control of tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois) during 2015 (http://www.entomology.msstate.edu/resources/tips/cotton-losses/data/). Cotton acreage in Arkansas is projected to be roughly 40-50% higher in 2016 or as much as 300,000 acres but it could be even higher. Due to market issues many growers have not decided which crops they will plant in 2016. If Arkansas goes higher than 300,000 acres we project a potential need to treat 80% or about 320,000 acres with sulfoxaflor for control of tarnished plant bug. This assessment is based on conservative estimates of the 2014 and 2015 crops where 100% of the acreage was treated. A recent survey conducted in 2015 with consultants in all cotton growing regions in Arkansas indicated that approximately 60% of the acreage in Arkansas was treated 6 to 8 times per year from 2014-2015. Another 15% were treated more than 8 times. There were 15% of fields treated less than 6 times per year with 10% treated 2 times per season.

vi. The total amount of pesticide proposed to be used:

Tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), infestations are likely to cause economic losses on approximately 320,000 acres in Arkansas during 2016. Therefore four applications of sulfoxaflor may be required on these acres to reduce the impact of this pest. The high rate (2.25 oz/acre) can only be used three times to prevent exceeding total annual rate of 8.25 oz product. Based upon this maximum allocation of 8.25 oz (1.5-2.25 oz of formulated product per acre per application), treated (total sprayed) acreage will require no more than 160,000 pounds of formulated product or 80,000 lbs of active ingredient on Arkansas's 320,000 acres.

vii. All applicable restrictions and requirements concerning the proposed use which may not appear on labeling:

Refer to the Transform® WG container label for first aid, precautionary statements, directions for use and conditions of sale and warranty information. It is a violation of federal law to use this product in a manner that is inconsistent with all applicable label directions, restrictions and precautions found in the container label and this supplemental label. Both the container label and this supplemental section 18 quarantine exemption label must be in the possession of the user at the time of application.

All applicable restrictions and requirements will appear on the package label and Section 18 label:

- Pre-harvest Interval: Do not apply within 14 d of harvest.
- Minimum Treatment Interval: Do not make applications less than 5 days apart.
- Do not make more than four applications per acre per season and no more than two applications during bloom.
- Do not apply more than a total of 8.5 oz of Transform WG (0.266 lb ai of sulfoxaflor) per acre per year. Use rate is 1.5 – 2.25 oz/ac (0.047 – 0.0071 lb ai/ac) per application. Annual use will not exceed 0.266 lb ai/ac
- Applications are restricted to cotton producing counties of Arkansas
- Label must include a pollinator advisory statement including but not limited to the following:
    - If known apiaries are within one mile of cotton fields intended for treatment, applications must be made within three hours of sunset during the flowering period.
    - Prior to use of Transform WG, growers and the beekeepers hosted on their farm are advised to implement cooperative standards outlined in the Arkansas Pollinator Stewardship Program
- Transform WG should be applied only when populations are above thresholds as published in the MP-144 Insecticide Recommendations for Arkansas, page 74 or page 80. The stated threshold is equal to or greater than 3 tarnished plant bugs per 5 row ft. on a drop cloth or one per 3 row feet on problem fields or 12 per 100 sweeps with a standard sweep net).

viii. The duration of the proposed use:

June – October of the 2016 cotton growing season

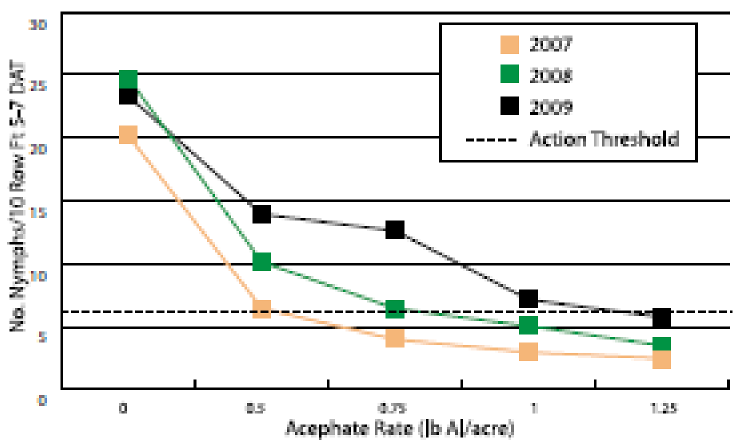
ix. Earliest possible harvest dates:

September 15, 2016

SECTION 166.20(a) 4: ALTERNATIVE METHODS OF CONTROL IN ARKANSAS

Chemical control strategies remain the primary tool used to manage this pest. Presently, numerous insecticides are recommended against tarnished plant bug, but varying levels of resistance has been documented to nearly every class of these compounds among Mid-South (Arkansas, Louisiana, Mississippi, Tennessee) populations of this insect. Populations have demonstrated resistance to pyrethroids and some organophosphates for several years (Snodgrass and Gore 2007), but many populations remained susceptible to neonicotinoid insecticides including thiamethoxam and imidacloprid (Snodgrass et al. 2008). Acephate has been the most widely used and effective insecticide for control of plant bugs in cotton but efficacy continues to decrease in Louisiana and much of the mid South. Three years of study by Copes et al. (2010) clearly shows that acephate efficacy is rapidly eroding across Louisiana (Figure 1, Copes et al. 2010).

Fig. 1. Three years, 2007-2009 of acephate efficacy Against the TPB in Louisiana field trials. The dotted Line indicates the action threshold of 6/ 10 row ft.



Even though acephate expressed partial efficacy against tarnished plant bugs in Arkansas, higher rates (0.5 to 1.25 lb AI/acre) were necessary each year from 2007-2009 to maintain the infestations below the action threshold. The highest rate actually exceeded the labeled rate that could be used. These field efficacy results are supported by laboratory data from Snodgrass which show significant levels of OP resistance in tarnished plant bug populations throughout the hills and delta in Arkansas, Louisiana, and Mississippi. During the past two years, populations in these states also have been expressing lower susceptibility to neonicotinoid products, but no high levels of resistance have been documented. (Snodgrass 2010 abstract, See Appendix A).

In our regional plant bug trial conducted in 2009-2010 the following list of currently labeled products were used to evaluate their efficacy against tarnished plant bug in the Midsouth (Table 1):

Table 1. Regional treatment list of currently labeled products tested.

Product	**Formulation**	**Rate/ Acre**
1. UTC		
2. Acephate	90 S or 97	0.75 lb
3. Bidrin	8 EC	6 oz
4. Vydate	3.77 C-LV	12 oz
5. Centric	40 WG	2 oz
6. Trimax Pro	4.44 SC	1.5 oz
7. Carbine	50 WG	2.5 oz
8. Leverage	2.7 SE	4.5 oz
9. Intruder	70 WP	1.1 oz
10. Endigo	2.06 ZC	5.0 oz
11. Diamond	0.83 EC	9.0 oz
12. Brigade	2 EC	5.12 oz

Cook et al. (2007) showed that standard insecticide use strategies can reduce tarnished plant bug numbers, but none are consistently effective and can maintain sub-economic injury levels for the season. During 2009 and 2010, the regional (Arkansas, Louisiana, Mississippi, and Tennessee) full-season insecticide screen was used to evaluate a list of products for control of tarnished plant bug (Fig 2, Lorenz et al., 2009 unpublished). As the data indicates no treatment of currently labeled products were able to lower plant bug numbers below the threshold of 6 plant bugs per 10 row feet at 6-10 days following the second application. (Figure 3, Lorenz et al. 2010 unpublished).

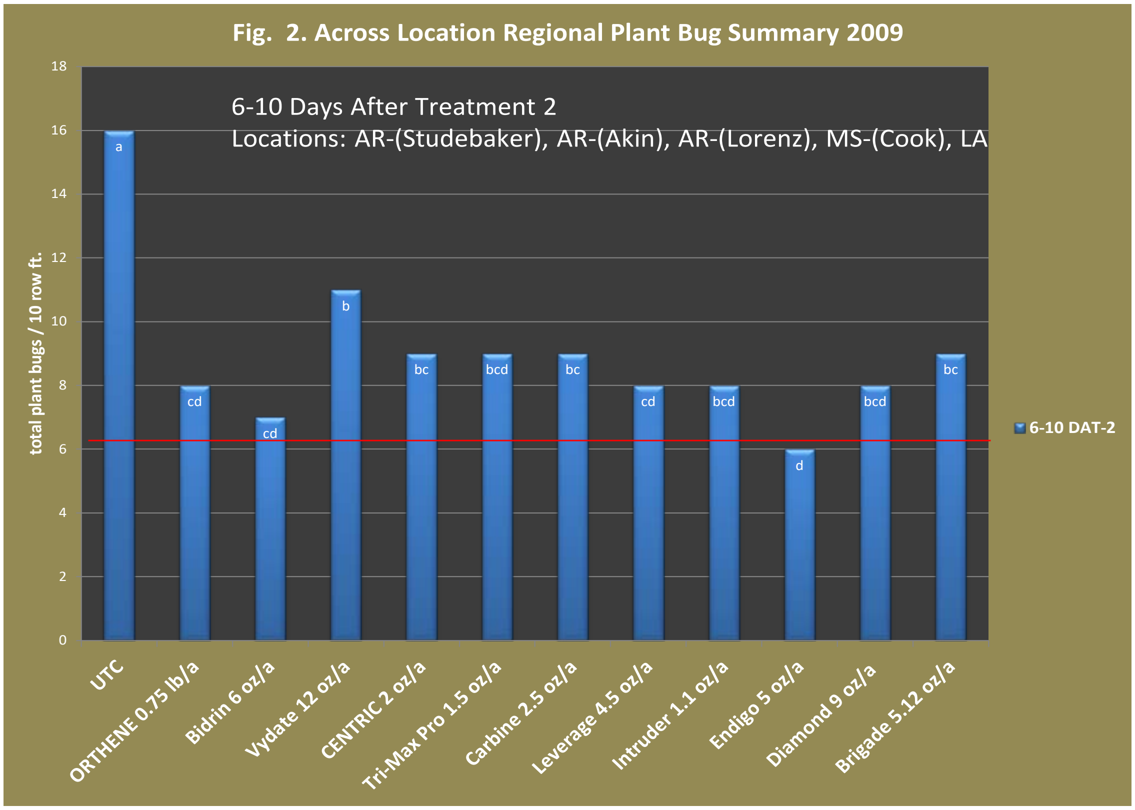


Figure 2. Regional plant bug efficacy trial summary across states, 2009.

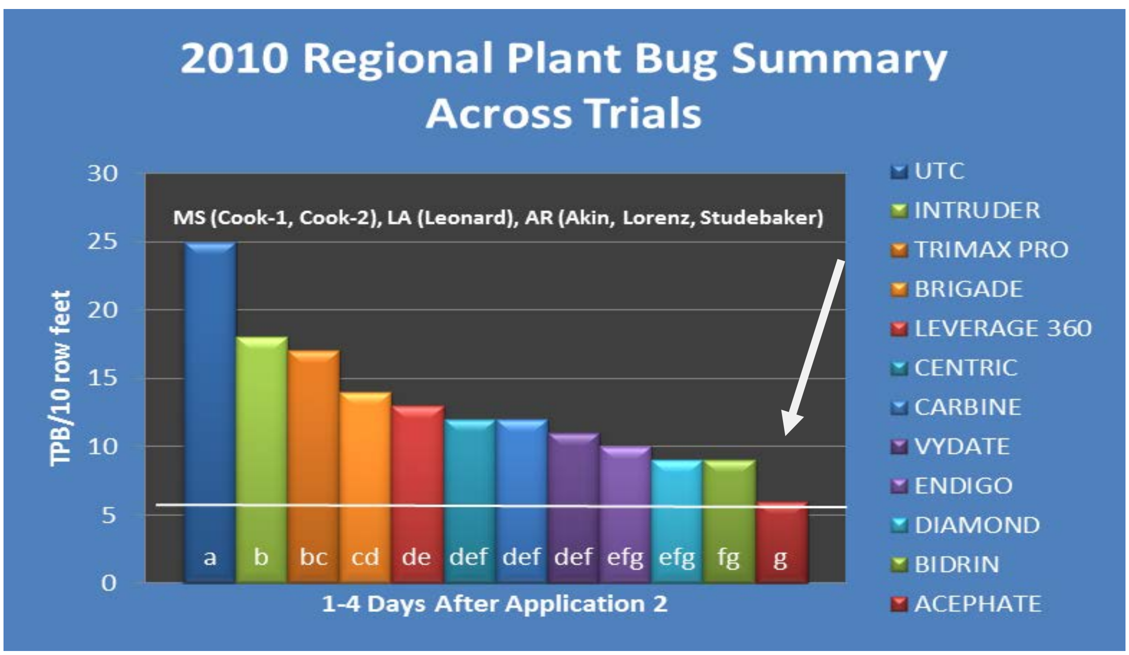


Figure 3. Regional plant bug efficacy trial summary across states, 2010.

In 2010 the figure above shows the lack of control for all currently labeled products for control of plant bugs in MS, LA and 3 locations in AR (Fig. 3).

Six sprays were applied to the Louisiana trial which was designed to simulate moderate to high pest infestation levels, typical of the situation in many Louisiana and Mid-South cotton fields (Figure 4, Sharp et al. 2010 and B. R. Leonard unpublished).

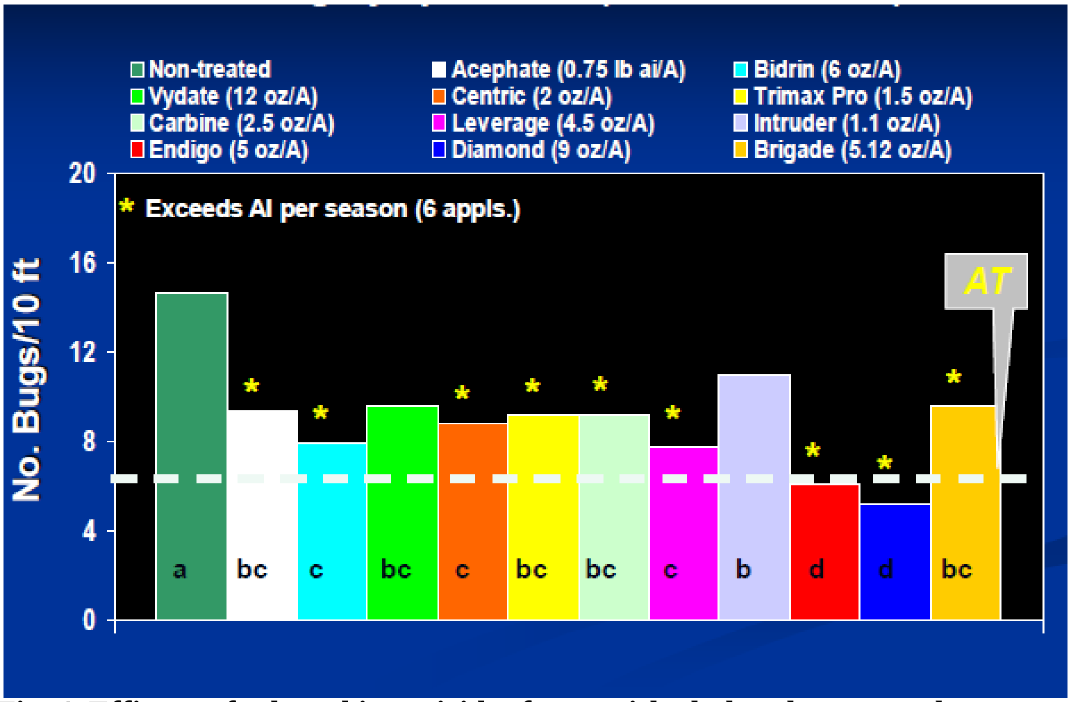


Fig. 4. Efficacy of selected insecticides for tarnished plant bug control.

Using seasonal means of tarnished plant bug nymphs as a metric for insecticide efficacy, all treatments significantly reduced numbers relative to a non-treated control. However, only Endigo and Diamond successfully reduced numbers below the action threshold (line marked with AT) used to gauge the need for additional treatments to stop yield losses. In addition, all of the bars highlighted with an asterisk (*) illustrate that six applications of those treatments exceeded the total allowable seasonal AI/acre. Only Vydate and Intruder AI's were not exceeded. Yield losses have become severe in these situations in spite of multiple insecticide sprays. Currently, the only chemical strategy recommended is to co-apply two insecticides and rotate among chemical classes.

In some areas across Arkansas and the Mid-South region, tarnished plant bug infestations have reached outbreak levels and become uncontrollable. In Mississippi during 2007, producers averaged approximately 7-10 insecticide applications for this pest (Catchot 2007). The highest insecticide application frequency in Mississippi prior to 2007 was 5.2 sprays per year and occurred during 2004 in that state. Arkansas producers averaged 3.5 applications during 2007 (Williams 2008) for this pest, but some areas received 8-10 treatments. In 2011 the average number of applications for this pest increased to 5 applications with some areas reporting 8 or more applications. Current trends with insecticide resistance and lack of effective alternative technologies will allow problems with tarnished plant bug management to intensify across Arkansas and the Mid-South states. Chemical control options that provide consistent efficacy are not available to manage this pest. Effective Lygus control is a serious, unmet need for Mid-South cotton growers and one that requires immediate and urgent action. This has now become an emergency situation.

These results have shown that regardless of the registered insecticide, tarnished plant bug populations in these states have become significantly more difficult to control using common recommended insecticides (Lorenz et al. 2009; Moore et al. 2010). As a result, the numbers of applications and use rates needed to control tarnished plant bug have increased. With a novel mode of action and chemical class, sulfoxaflor will successfully control both insecticide-susceptible and -resistant populations of tarnished plant bug, thereby improving the overall cotton IPM system. This would be a tremendous economic opportunity for cotton growers, and more environmentally-friendly alternative to the sustained frequency of the currently used products.

As expected, the excessive use of some products for tarnished plant bug are now beginning to induce additional pest problems (spider mites and cotton aphids) in some areas. This is of great concern to many producers and pest management practitioners. Organophosphate, carbamate and pyrethroid insecticides can impact natural beneficial arthropod populations and flare secondary insects. Acephate is commonly used for Lygus control and can flare aphids and mites. Pyrethroid insecticides may flare aphids and mites, as well. Sulfoxaflor should reduce the frequency of selected insecticides used, especially acephate, dicrotophos, and oxamyl. The ecological and toxicological profile of sulfoxaflor is considered to be more favorable than the ecological and toxicological profiles of these insecticides. Limited data currently suggest that sulfoxaflor is not likely to flare aphids and mites. A comparison of the years 2008-2011 and 2012-2015 indicate that Arkansas has seen a yield increase of 15% while acreage has decreased by 38%, however, the number of tarnished plant bug applications has increased by 33% ~1.6 more applications per season (Table 2.):

Table 2. Comparison of 2008-2011 prior to Transform and 2012-2015 with Transform in Arkansas.

Pre Transform Use In Arkansas				**Post Transform Use in Arkansas**			
Year	**Yield**	**Acres**	**TPB Sprays**	**Year**	**Yield**	**Acres**	**TPB Sprays**
2008	1012	615000	1.9	2012	1064	585000	5.1
2009	818	500000	2.9	2013	1133	305000	6
2010	1045	540000	2.8	2014	1145	330000	6
2011	929	660000	4.4	2015	1112	205000	6
Percent Change Pre and Post Transform Use					**15%**	**-38%**	**33%**

ii. A detailed explanation of why alternative practices, if available, either would not provide adequate control or would not be economically or environmentally feasible.

Several IPM strategies are recommended for controlling tarnished plant bug in cotton (Gore et al. 2008). Non-chemical tactics include area-wide control of non-crop alternate hosts and selected host plant resistance traits. Proper selection of varieties and managing the optimum planting period are being to produce a rapid fruiting and early maturing crop; thereby reducing the time the crop is susceptible to this pest. Careful insecticide application timing based upon revised spray action thresholds are used to precisely target populations before they reach outbreak levels. All of these practices are currently in place and are being used by cotton producers. However, these strategies only serve to suppress populations and are not effective as stand-alone practices. Effective chemical control practices are still necessary to provide tarnished plant bug management in cotton.

Over the last ten years, field use rates have more than doubled and control has continued to decline. This has put a tremendous amount of pressure on the neonicotinoid class. Of that class, thiamethoxam is by far the most effective for tarnished plant bug control. Consequently, two to four pre-flower applications in cotton target both tarnished plant bugs and cotton aphids. Centric (thiamethoxam) has been the insecticide of choice in this situation because it provides better control of the whole pest complex than other neonicotinoids at that time of the year. The most common rate used at that time of year is 2 oz formulated product per acre (0.05 lbs ai/A). The maximum seasonal use rate for Centric is 5.0 oz (0.125 lb ai thiamethoxam). Therefore, two applications of Centric at 2 oz/A (0.05 lbs ai per acre per application) during the pre-flowering period does not leave enough active ingredient for later applications of either Centric or Endigo (thiamethoxam + lambda-cyhalothrin). Recently the control observed with Centric has declined and is not as effective in recent years. USDA has reported increased tolerance to thiamethoxam (pers comm 2016). The only other labeled insecticides available are Carbine (flonicamid) and Diamond (novaluron). Figure 4 above shows typical results observed with Carbine in Mississippi and other mid-South states for tarnished plant bug. Diamond is the only other insecticide available for late season tarnished plant bug control. As mentioned previously, Diamond is an insect growth regulator that only controls the immature stages. Therefore, Diamond applications are exclusively used with another class of chemistry to control adults. Also, application timing is critical with this insecticide and applications are often sprayed too late to provide the most effective levels of control. Therefore, the use of one or two applications of Transform will provide significant economic benefits for cotton growers in Arkansas.

SECTION 166.20(a) 5: EFFECTIVENESS OF PROPOSED USE

Value of Transform in an Overall IPM Approach for Tarnished Plant Bug in Cotton: Sulfoxaflor (DAS test code GF-2372, proposed trade name Transform^{TM}) has been evaluated in laboratory and field trials for the past several years. Recent publications by Babcock et al. (2010, See Appendix B) and Zhu et al. (2010, See Appendix C) clearly define the biology and biochemistry of sulfoxaflor and demonstrate a novel mode of action against sap feeding insects including those in the order Heteroptera. Insects in the genus *Lygus* are included this order. Sulfoxaflor-induced mortality was similar between insecticide-resistant and –susceptible strains of several Homoptera and Heteroptera. No cross-resistance was detected to sulfoxaflor in populations expressing resistance to a broad range of modes of action. The effectiveness of sulfoxaflor against insecticide-susceptible populations of tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois) was comparable to those of other labeled classes of insecticides. These research projects support a novel mode of action for sulfoxaflor including those insecticides with similar chemical structures (neonicotinoids).

Numerous field trials were performed during 2008-2010 across the Mid-South States and in Arkansas (Appendix D) against tarnished plant bug and are in the process of being published, trial results showed that Sulfoxaflor was usually as good as standards but often much better. The first field results were reported by Smith et al. (2010, See Appendix E) for Mississippi trials and show levels of efficacy comparable to or significantly better than standards (acephate, Bifenthrin, thiamethoxam) on one or more sample periods against tarnished plant bug nymphs. For Louisiana during 2009-2010, Hardke (2011, Submitted to Entomological Society of America's Arthropod Management Tests, See Appendix F) summarized the results of field trials for sulfoxaflor performance against tarnished plant bug. In the 2009 trials, effective rates and application frequencies were defined compared to standard products. In a co-application trial with a pyrethroid-resistant population, sulfoxaflor outperformed Endigo and Bifenthrin (alone) on one or more post-treatment evaluation dates. Based upon total insects during 2010, sulfoxaflor at the upper rate and in combination with novaluron demonstrated significantly better control of tarnished plant bugs than acephate and efficacy equivalent to a combination of a pyrethroid and thiamethoxam (Endigo). Reports of additional field trials from Arkansas, Mississippi, and Tennessee are in preparation and will serve to support the Louisiana results.

A multi-state (AR, LA, MS, TN) summary of field trials against "high pressure" tarnished plant bug infestations on cotton during 2008-2010 is reported in Appendix G. These results demonstrated sulfoxaflor at one or more rates demonstrated control of plant bugs (high population levels) superior to the OP, dicrotophos. The residual efficacy of sulfoxaflor was greater than that for both dicrotophos and thiamethoxam. Efficacy was similar to a co-application of a pyrethroid + neonicotinoid. In a comparison of cotton yields among treatments for these trials, sulfoxaflor was similar to that of acephate (Acephate is broader spectrum and may have provided some yield increase from additional caterpillar pest control). Pest management practitioners recognize that sulfoxaflor should not be used as a single, season-long treatment, so chemical control strategies with co-applications and/or rotation for sequential treatments are the logical use pattern.

Other studies conducted in Arkansas show the yield loss associated with the current standard (acephate) and the increased yield of sulfoxaflor, well exceeding 20% in 2009 (Table 3.) and up to 46% in 2010 (Table 4).

Table 3. Efficacy and yield comparison of selected Transform rates and acephate, 2009.

Transform Trial 2009			
Treatments	Season Total Plant Bugs	Harvest Lint lbs/acre	% Yield above UTC
Transform 0.045 lb ai/a AB	59.3 d	587 a	126%
Transform 0.022 lb ai/a AB	108 c	538 ab	107%
Transform 0.034 lb ai/a AB	79 d	522 ab	101%
Orthene 1 lb/a A	178.3 b	475 bc	83%
UTC	276.3 a	260 d	

Table 4. Efficacy and yield comparison of selected Transform rates and acephate, 2010.

PB5-2010				
Treatment	**Plant Bugs 3DAT**	**Season Total Plant Bugs**	**Yield lint lbs/acre**	**% Yield above UTC**
Transform 0.045 lb ai/a	18.3 cd	93.3 c	1231 a	36%
Endigo 5 oz/a	18.8 cd	105.5 c	1136 ab	26%
Bidrin 6 oz/a	6.3 d	100.5 c	1100 ab	22%
Transform 0.067 lb ai/a	17.5 cd	86.5 c	1065 abc	18%
Acephate 0.5 lb./acre	53.8 b	185 b	833 c	-8%
Untreated Check (UTC)	105.8 a	309.8 a	903 bc	

When sulfoxaflor was evaluated as a component of this type of strategy, those use patterns with sulfoxaflor maintained tarnished plant bug populations below the action threshold for the duration of the trial; whereas a standard strategy was unable to provide satisfactory control. In a commercial field, the standard treatments (without sulfoxaflor) would have required additional applications to reduce populations. In the season-long trials, strategies relying on sulfoxaflor significantly increased cotton yield above the standard-treated and non-treated plots. Willrich et al. (2010, see Appendix H) further summarized results for 2008-2009 as an abstract and reported sulfoxaflor's acute toxicity for knockdown of tarnished plant bug infestations at ≤ 5 d and residual control extending for ≥ 7 d. In addition, cotton treated with sulfoxaflor produced lint yields equal to or superior than cotton treated with acephate (1.0 lb AI/acre) across 16 trials. Recent trial results continue to show the efficacy of Transform has not diminished as shown in the Tables 5 and 6 below from a trial conducted in 2014 and 2015, respectively.

Table 5. Efficacy of selected insecticides for control of tarnished plant bug showing total plant bugs sampled, yield and yield reduction compared to Transform. 2014.

Treatment	Season Total Plant Bugs	Yield lbs/acre	% below
Transform 1.75 oz	19	5326.6	
UTC	149	2499	-53
Bidrin 6 oz/acre*	38	4237.9	-20
Brigade 5.6 oz/acre*	70.4	3598	-32
Sivanto 14 oz/acre	85	2804.8	-47
Vydate C-LV 10.7 oz/acre	51	3151.8	-41
DoubleTake 4 oz/acre	143	2473.8	-54

Table 6. Efficacy of selected insecticides showing total number of plant bugs sampled, yield and percentage of reduced yield compared to Transform. 2015.

Treatment	Season Total Plant Bugs	Yield pounds/acre	% below
Transform 1.75 oz	45	4157	
UTC	140	3244.1	-22%
Strafer 3 oz	61	3307.2	-20%
Centric 2 oz	75	3387.4	-19%
Centric 2 oz & Diamond 6 oz	65	3426.1	-18%
Orthene 1 lb	46	3335.8	-20%

Transform averaged about 20% better control and the same for increased yield over other treatments.

Value of Transform in an Overall IPM Approach for Tarnished Plant Bug in Cotton
Multiple experiments have been conducted throughout Mississippi to evaluate an overall integrated pest management approach for tarnished plant bug in cotton and the importance of various insecticides in that approach. Inconsistent control with most of the currently labeled insecticides due to documented resistance highlighted above has forced growers to adopt multiple best management practices to economically manage tarnished plant bug. Although these best management practices have improved tarnished plant bug management, insecticides remain an important component. In particular, the registration of sulfoxaflor in 2012 (Section 18 in 2012 and Section 3 in 2013-15) increased the adoption of the overall IPM approach.

Sulfoxaflor rapidly became the foundation for the IPM approach because of its high level of efficacy against tarnished plant bug and the relative safety for beneficial insects (Fig. 5). Even at very high use rates (100 g ai/ha=3.0 oz./A), significantly more beneficial arthropods were conserved compared to the pyrethroid (Warrior) and the organophosphate (Orthene). Similar results were observed by Kerns et al. (2011) where densities of convergent lady beetles for sulfoxaflor were not significantly different than Carbine. Both the Carbine and sulfoxaflor had significantly lower densities than the untreated control which was most likely due to the reduction in prey (cotton aphid) in the treated plots.

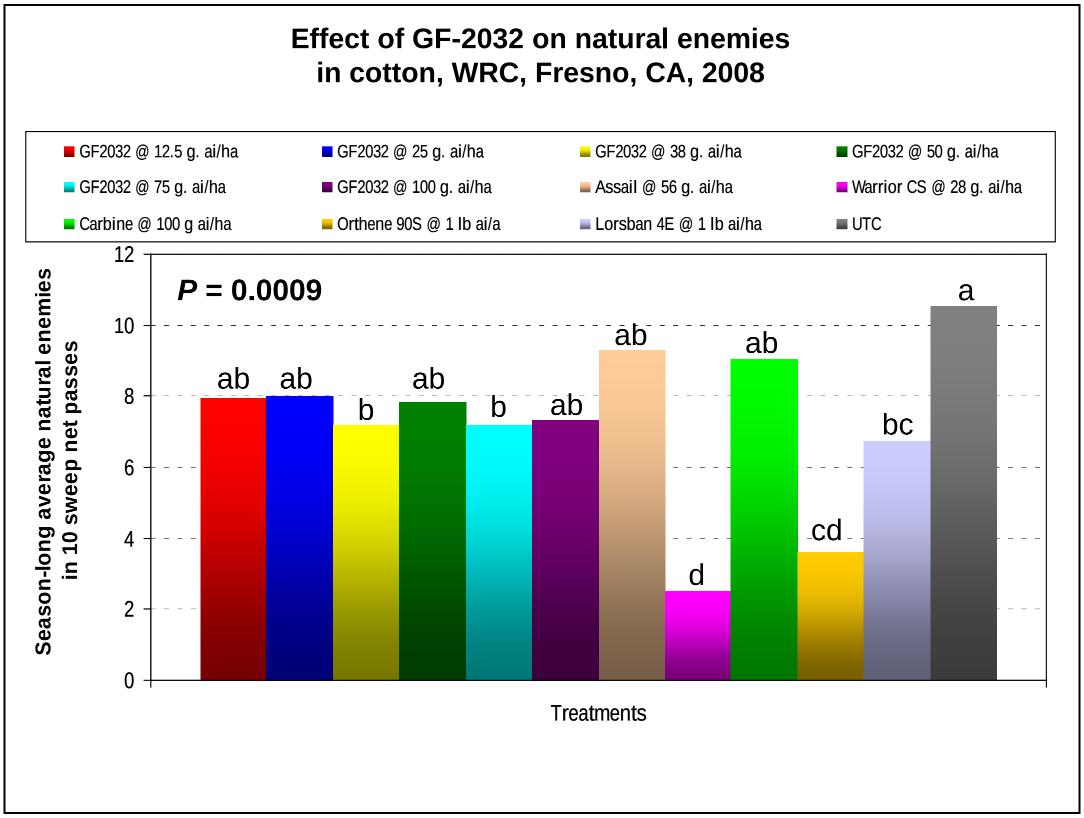
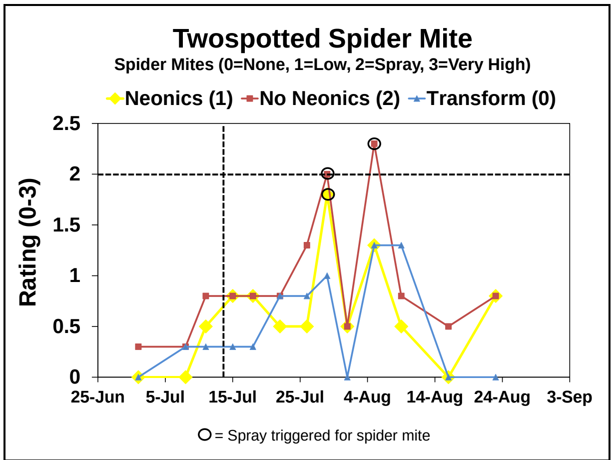


Figure 5. Impact of various rates of sulfoxaflor and other insecticides on natural enemy populations in cotton in California.

Although natural enemy populations provide little benefit for tarnished plant bug management, sprays with high rates of organophosphates and pyrethroids (usually applied as a tank mix) targeting tarnished plant bug reduce natural enemy populations and "flare" other pests such as two spotted spider mite or cotton aphid. A study conducted in Stoneville, MS in 2013 compared overall management programs. The treatments included cotton grown with all classes except neonicotinoids or sulfoxaflor, all classes except sulfoxaflor, and all available classes. Overall, one to two applications were needed for two spotted spider mite in the treatments where sulfoxaflor was not used (Figure 6). Additionally, the treatments that did not include sulfoxaflor each needed to be sprayed separately for cotton aphid (Figure 6). A portion of this is due to sulfoxaflor control of cotton aphids, but preservation of beneficial insects also contributed. In summary, the use of sulfoxaflor for tarnished plant bug management can reduce the number of insecticide applications targeting other pests because of the lower toxicity to beneficial arthropods. Overall, yields and economic returns were greater where all classes of insecticides were included.



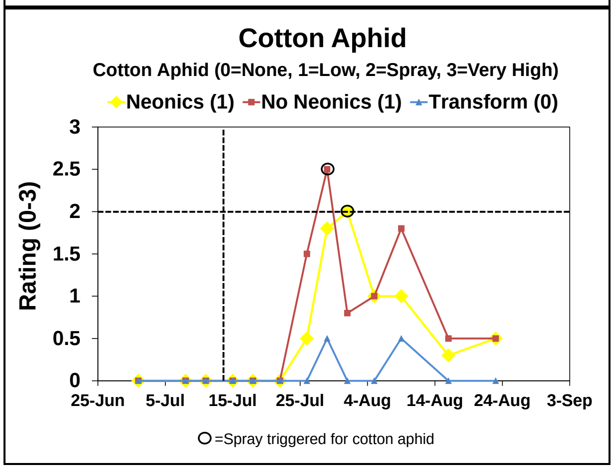


Figure 6. Impact of insecticide use programs for tarnished plant bug management on the number of insecticide sprays for two spotted spider mite and cotton aphid.

The tarnished plant bug IPM program has been important for increasing the profitability of cotton programs in Mid-South cotton. However, diversity in the available classes of insecticides available to manage tarnished plant bug is critical to make the overall IPM approach successful. In particular, insecticides that provide high levels of efficacy against tarnished plant bug that do not flare other pests provide the foundation for the overall cotton IPM program. Two insecticides have proven to be very important in this respect. Research throughout the Mid-South has shown that a single application of the insect growth regulator, novaluron, can provide long term benefits for tarnished plant bug management. However, novaluron does not control adult plant bugs and it consistently flares cotton aphids. As a result, sulfoxaflor is the ideal insecticide to use as one to two applications immediately following the novaluron application. Additionally, the registration of sulfoxaflor provided growers with a legitimate insecticide rotation strategy to make the tarnished plant bug IPM program successful.

All available data indicates that sulfoxaflor is an alternative product to the insecticides currently used to manage tarnished plant bug on cotton. It is an excellent tool for Arkansas and Mid-South cotton IPM programs by improving efficacy, reducing input costs, and increasing yields. This compound has a selective spectrum of activity, has not flared other pests, can be used as a rotational partner with other chemistries, and has demonstrated value against insecticide-resistant populations. Sulfoxaflor is the backbone of chemical control strategies for tarnished plant bug and is desperately needed in this emergency situation. Sulfoxaflor has been widely adopted by producers because of safety to pollinators and other beneficial insects. Two of the largest beekeepers in Arkansas have shown their support for Transform use on cotton (Attachment 2 & 3). This product has allowed growers to further implement IPM programs due to the safety profile. Additionally, since its use in 2012 in cotton there has not been a single incident reported with managed bees. It also provides for insecticide resistance management which is, or should be, a concern for everyone.

SECTION 166.20(a) 6: EXPECTED RESIDUE LEVELS IN FOOD

Acute Assessment

Food consumption information from the USDA 1994-1996 and 1998 Nationwide Continuing Surveys of Food Intake by Individuals (CSFII) and maximum residues from field trials rather than tolerance-level residue estimates were used. It was assumed that 100% of crops covered by the registration request are treated and maximum residue levels from field trials were used.

Drinking water. Two scenarios were modeled, use of sulfoxaflor on non-aquatic row and orchard crops and use of sulfoxaflor on watercress. For the non-aquatic crop scenario, based on the Pesticide Root Zone Model/Exposure Analysis Modeling System (PRZM/EXAMS) and Screening Concentration in Ground Water (SCI-GROW) models, the estimated drinking water concentrations (EDWCs) of sulfoxaflor for acute exposures are 26.4 ppb for surface water and 69.2 ppb for ground water. For chronic exposures, EDWCs are 13.5 ppb for surface water and 69.2 ppb for ground water. For chronic exposures for cancer assessments, EDWCs are 9.3 ppb for surface water and 69.2 ppb for ground water. For the watercress scenario, the EDWCs for surface water are 91.3 ppb after one application, 182.5 ppb after two applications and 273.8 ppb after three applications.

Dietary risk estimates using both sets of EDWCs are below levels of concern. The non-aquatic-crop EDWCs are more representative of the expected exposure profile for the majority of the population. Also, water concentration values are adjusted to take into account the source of the water; the relative amounts of parent sulfoxaflor, X11719474, and X11519540; and the relative liver toxicity of the metabolites as compared to the parent compound.

For acute dietary risk assessment of the general population, the groundwater EDWC is greater than the surface water EDWC and was used in the assessment. The residue profile in groundwater is 60.9 ppb X11719474 and 8.3 ppb X11519540 (totaling 69.2 ppb). Parent sulfoxaflor does not occur in groundwater. The regulatory toxicological endpoint is based on neurotoxicity.

For acute dietary risk assessment of females 13-49, the regulatory endpoint is attributable only to the parent compound; therefore, the surface water EDWC of 9.4 ppb was used for this assessment.

A tolerance of 0.3 ppm for sulfoxaflor on grain sorghum has been established. There is no expectation of residues of sulfoxaflor and its metabolites in animal commodities as a result of the proposed use on sorghum. Thus, animal feeding studies are not needed, and tolerances need not be established for meat, milk, poultry, and eggs.

Drinking water exposures are the driver in the dietary assessment accounting for 100% of the exposures. Exposures through food (sorghum grain and syrup) are zero.

The acute dietary exposure from food and water to sulfoxaflor is 16% of the aPAD for children 1-2 years old and females 13-49 years old, the population groups receiving the greatest exposure.

Chronic Assessment

The same refinements as those used for the acute exposure assessment were used, with two exceptions: (1) average residue levels from crop field trials were used rather than maximum values and (2) average residues from feeding studies, rather than maximum values, were used to derive residue estimates for livestock commodities. It was assumed that 100% of crops are treated and average residue levels from field trials were used.

For chronic dietary risk assessment, the toxicological endpoint is liver effects, for which it is possible to account for the relative toxicities of X11719474 and X11519540 as compared to sulfoxaflor. The groundwater EDWC is greater than the surface water EDWC. The residue profile in groundwater is 60.9 ppb X11719474 and 8.3 ppb X11519540. Adjusting for the relative toxicity results in 18.3 ppb equivalents of X11719474 and 83 ppb X11519540 (totaling 101.3 ppb). The adjusted groundwater EDWC is greater than the surface water EDWC (9.3 ppb) and was used to assess the chronic dietary exposure scenario.

The maximum dietary residue intake via consumption of sorghum commodities would be only a small portion of the RfD (<0.001%) and therefore, should not cause any additional risk to humans via chronic dietary exposure. Consumption of sorghum by sensitive sub-populations such as children and non-nursing infants is essentially zero. Thus, the risk of these subpopulations to chronic dietary exposure to sulfoxaflor used on grain sorghum would be insignificant.

The major contributor to the risk was water (100%). There was no contribution from grain sorghum to the dietary exposure. All other populations under the chronic assessment show risk estimates that are below levels of concern.

Chronic exposure to sulfoxaflor from food and water is 18% of the cPAD for infants, the population group receiving the greatest exposure. There are no residential uses for sulfoxaflor.

Short-term risk. Because there is no short-term residential exposure and chronic dietary exposure has already been assessed, no further assessment of short-term risk is necessary, the chronic dietary risk assessment for evaluating short-term risk for sulfoxaflor is sufficient.

Intermediate-term risk. Intermediate-term risk is assessed based on intermediate-term residential exposure plus chronic dietary exposure. Because there is no residential exposure and chronic dietary exposure has already been assessed, no further assessment of intermediate-term risk is necessary.

Cumulative effects. Sulfoxaflor does not share a common mechanism of toxicity with any other substances, and does not produce a toxic metabolite produced by other substances. Thus, sulfoxaflor does not have a common mechanism of toxicity with other substances.
Cancer. A nonlinear RfD approach is appropriate for assessing cancer risk to sulfoxaflor. This approach will account for all chronic toxicity, including carcinogenicity that could result from exposure to sulfoxaflor. Chronic dietary risk estimates are below levels of concern; therefore, cancer risk is also below levels of concern.

There is a reasonable certainty that no harm will result to the general population, or to infants and children from aggregate exposure to sulfoxaflor as used in this emergency exemption request.

The content in the above Section 166.20(a)(6): "Expected Residues For Food Uses" was prepared by Michael Hare, Ph.D., Texas Department of Agriculture.

SECTION 166.20(a) 7: DISCUSSION OF RISK INFORMATION

Human Health Effects – Michael Hare, Ph.D.
Ecological Effects – David Villarreal, Ph.D.
Environmental Fate – David Villarreal, Ph.D.

Human Health

Toxicological Profile
Sulfoxaflor is a member of a new class of insecticides, the sulfoximines. It is an activator of the nicotinic acetylcholine receptor (nAChR) in insects and, to a lesser degree, mammals. The nervous system and liver are the target organs, resulting in developmental toxicity and hepatotoxicity.

Developmental toxicity was observed in rats only. Sulfoxaflor produced skeletal abnormalities likely resulting from skeletal muscle contraction due to activation of the skeletal muscle nAChR in utero. Contraction of the diaphragm, also related to skeletal muscle nAChR activation, prevented normal breathing in neonates and increased mortality. The skeletal abnormalities occurred at high doses while decreased neonatal survival occurred at slightly lower levels.

Sulfoxaflor and its major metabolites produced liver weight and enzyme changes, and tumors in sub chronic, chronic and short-term studies. Hepatotoxicity occurred at lower doses in long-term studies compared to short-term studies.

Reproductive effects included an increase in Leydig cell tumors which were not treatment related due to the lack of dose response, the lack of statistical significance for the combined tumors, and the high background rates for this tumor type in F344 rats. The primary effects on male reproductive organs are secondary to the loss of normal testicular function due to the size of the Leydig Cell adenomas. The secondary effects to the male reproductive organs are also not treatment related. It appears that rats are uniquely sensitive to these developmental effects and are unlikely to be relevant to humans.

Clinical indications of neurotoxicity were observed at the highest dose tested in the acute neurotoxicity study in rats. Decreased motor activity was also observed in the mid- and high-dose groups. Since the neurotoxicity was observed only at a very high dose and many of the effects are not consistent with the perturbation of the nicotinic receptor system, it is unlikely that these effects are due to activation of the nAChR.

Tumors have been observed in rat and mouse studies. In rats, there were significant increases in hepatocellular adenomas in the high-dose males. In mice, there were significant increases in hepatocellular adenomas and carcinomas in high dose males. In female mice, there was an increase in carcinomas at the high dose. Liver tumors in mice were treatment-related. Leydig cell tumors were also observed in the high-dose group of male rats, but were not related to treatment. There was also a significant increase in preputial gland tumors in male rats in the high-dose group. Given that the liver tumors are produced by a non-linear mechanism, the Leydig cell tumors were not treatment-related, and the preputial gland tumors only occurred at the high dose in one sex of one species, the evidence of carcinogenicity was weak.

Ecological Toxicity

Sulfoxaflor (N-[methyloxido[1-[6-(trifluoromethyl)-3-pyridinyl]ethyl]-lambda 4-sulfanylidene]) is a new variety of insecticide as a member of the sulfoxamine subclass of neonicotinoid insecticides. It is considered an agonist of the nicotinic acetylcholine receptor and exhibits excitatory responses including tremors, followed by paralysis and mortality in target insects. Sulfoxaflor consists of two diastereomers in a ratio of approximately 50:50 with each diastereomer consisting of two enantiomers. Sulfoxaflor is systemically distributed in plants when applied. The chemical acts through both contact action and ingestion and provides both rapid knockdown (symptoms are typically observed within 1-2 hours of application) and residual control (generally provides from 7 to 21 days of residual control). Incident reports submitted to EPA since approximately 1994 have been tracked via the Incident Data System. Over the 2012 growing season, a Section 18 emergency use was granted for application of sulfoxaflor to cotton in four states (MS, LA, AR, and TN). No incident reports have been received in association with the use of sulfoxaflor in this situation.

Sulfoxaflor is classified as practically non-toxic on an acute exposure basis, with 96-h LC_{50} values of >400 mg a.i./L for all three freshwater fish species tested (bluegill, rainbow trout, and common carp). Mortality was 5% or less at the highest test treatments in each of these studies. Treatment-related sub lethal effects included discoloration at the highest treatment concentration (100% of fish at 400 mg a.i./L for bluegill) and fish swimming on the bottom

(1 fish at 400 mg a.i./L for rainbow trout). No other treatment-related sub lethal effects were reported. For an estuarine/marine sheepshead minnow, sulfoxaflor was also practically non-toxic with an LC_{50} of 288 mg a.i./L. Sub lethal effects included loss of equilibrium or lying on the bottom of aquaria at 200 and 400 mg a.i./L. The primary degradate of sulfoxaflor is also classified as practically non-toxic to rainbow trout on an acute exposure basis (96-h LC_{50} >500 mg a.i./L).

Adverse effects from chronic exposure to sulfoxaflor were examined with two fish species (fathead minnow and sheepshead minnow) during early life stage toxicity tests. For fathead minnow, the 30-d NOAEC is 5 mg a.i./L based on a 30% reduction in mean fish weight relative to controls at the next highest concentration (LOAEC=10 mg a.i./L). No statistically significant and/or treatment-related effects were reported for hatching success, fry survival and length. For sheepshead minnow, the 30-d NOAEC is 1.3 mg a.i./L based on a statistically significant reduction in mean length (3% relative to controls) at 2.5 mg a.i./L. No statistically significant and/or treatment-related effects were reported for hatching success, fry survival and mean weight.

The acute toxicity of sulfoxaflor was evaluated for one freshwater invertebrate species, the water flea and two saltwater species (mysid shrimp and Eastern oyster). For the water flea, the 48-h EC_{50} is >400 mg a.i./L, the highest concentration tested. For Eastern oyster, new shell growth was significantly reduced at 120 mg a.i./L (75% reduction relative to control). The 96-h EC_{50} for shell growth is 93 mg a.i./L. No mortality occurred at any test concentration. Mysid shrimp are the most acutely sensitive invertebrate species tested with sulfoxaflor based on water column only exposures, with a 96-h LC_{50} of 0.67 mg a.i./L. The primary degradate of sulfoxaflor is also classified as practically non-toxic to the water flea (EC_{50} >240 mg a.i./L).

The chronic effects of sulfoxaflor to the water flea were determined in a semi-static system over a period of 21 days to nominal concentrations of 6.25, 12.5, 25, 50 and 100 mg a.i./L. Adult mortality, reproduction rate (number of young), length of the surviving adults, and days to first brood were used to determine the toxicity endpoints. No treatment-related effects on adult mortality or adult length were observed. The reproduction rate and days to first brood were significantly ($p<0.05$) different in the 100 mg a.i./L test group (40% reduction in mean number of offspring; 35% increase in time to first brood). No significant effects were observed on survival, growth or reproduction at the lower test concentrations. The 21-day NOAEC and LOAEC were determined to be 50 and 100 mg a.i./L, respectively.

The chronic effects of sulfoxaflor to mysid shrimp were determined in a flow-through system over a period of 28 days to nominal concentrations of 0.063, 0.13, 0.25, 0.50 and 1.0 mg a.i./L. Mortality of parent (F_0) and first generation (F_1), reproduction rate of F_0 (number of young), length of the surviving F_0 and F_1, and days to first brood by F_0 were used to determine the toxicity endpoints. Complete F_0 mortality (100%) was observed at the highest test concentration of 1.0 mg a.i./L within 7 days; no treatment-related effects on F_0/F_1 mortality, F_0 reproduction rate, or F_0/F_1 length were observed at the lower test concentrations. The 28-day NOAEC and LOAEC were determined to be 0.11 mg and 0.25 mg a.i./L, respectively.

Sulfoxaflor exhibited relatively low toxicity to aquatic non-vascular plants. The most sensitive aquatic nonvascular plant is the freshwater diatom with a 96-h EC_{50} of 81.2 mg a.i./L. Similarly, sulfoxaflor was not toxic to the freshwater vascular aquatic plant, *Lemna gibba*, up to the limit amount, as indicated by a 7-d EC_{50} for frond count, dry weight and growth rate of >100 mg a.i./L with no significant adverse effects on these endpoints observed at any treatment concentration.

Based on an acute oral LD_{50} of 676 mg a.i./kg bw for bobwhite quail, sulfoxaflor is considered slightly toxic to birds on an acute oral exposure basis. On a subacute, dietary exposure basis, sulfoxaflor is classified as practically nontoxic to birds, with 5-d LC_{50} values of >5620 mg/kg-diet for mallard ducks and bobwhite quail. The NOAEL from these studies is 5620 mg/kg-diet as no treatment related mortality of sub lethal effects were observed at any treatment. Similarly, the primary degradate is classified as practically nontoxic to birds on an acute oral exposure basis with a LD_{50} of >2250 mg a.i./kg bw. In two chronic, avian reproductive toxicity studies, the 20-week NOAELs ranged from 200 mg/kg-diet (mallard, highest concentration tested) to 1000 mg/kg-diet (bobwhite quail, highest concentration tested). No treatment-related adverse effects were observed at any test treatment in these studies.

For bees, sulfoxaflor is classified as very highly toxic with acute oral and contact LD_{50} values of 0.05 and 0.13 µg a.i./bee, respectively, for adult honey bees. For larvae, a 7-d oral LD_{50} of >0.2 µg a.i./bee was determined (45% mortality occurred at the highest treatment of 0.2 µg a.i./bee). The primary metabolite of sulfoxaflor is practically non-toxic to the honey bee. This lack of toxicity is consistent with the cyano-substituted neonicotinoids where similar cleavage of the cyanide group appears to eliminate their insecticidal activity. The acute oral toxicity of sulfoxaflor to adult bumble bees (*Bombus terrestris*) is similar to the honey bee; whereas its acute contact toxicity is about 20X less toxic for the bumble bee. Sulfoxaflor did not demonstrate substantial residual toxicity to honey bees exposed via treated and aged alfalfa (i.e., mortality was <15% at maximum application rates).

At the application rates used (3-67% of US maximum), the direct effects of sulfoxaflor on adult forager bee mortality, flight activity and the occurrence of behavioral abnormalities is relatively short-lived, lasting 3 days or less. Direct effects are considered those that result directly from interception of spray droplets or dermal contact with foliar residues. The direct effect of sulfoxaflor on these measures at the maximum application rate in the US is presently not known. When compared to control hives, the effect of sulfoxaflor on honey bee colony strength when applied at 3-32% of the US maximum proposed rate was not apparent in most cases. When compared to hives prior to pesticide application, sulfoxaflor applied to cotton foliage up to the maximum rate proposed in the US resulted in no discernible decline in mean colony strength by 17 days after the first application. Longer-term results were not available from this study nor were concurrent controls included. For managed bees, the primary exposure routes of concern include direct contact with spray droplets, dermal contact with foliar residues, and ingestion through consumption of contaminated pollen, nectar and associated processed food provisions. Exposure of hive bees via contaminated wax is also possible. Exposure of bees through contaminated drinking water is not expected to be nearly as important as exposure through direct contact or pollen and nectar.

In summary, sulfoxaflor is slightly toxic to practically non-toxic to fish and freshwater water aquatic invertebrates on an acute exposure basis. It is also practically non-toxic to aquatic plants (vascular and non-vascular). Sulfoxaflor is highly toxic to saltwater invertebrates on an acute exposure basis. The high toxicity of sulfoxaflor to mysid shrimp and benthic aquatic insects relative to the water flea is consistent with the toxicity profile of other insecticides with similar MOAs. For birds and mammals, sulfoxaflor is classified as moderately toxic to practically non-toxic on an acute exposure basis. The threshold for chronic toxicity (NOAEL) to birds is 200 ppm and that for mammals is 100 ppm in the diet. Sulfoxaflor did not exhibit deleterious effects to terrestrial plants at or above its proposed maximum application rates.

For bees, sulfoxaflor is classified as very highly toxic. However, if this insecticide is strictly used as directed on the Section 18 supplemental label, no significant adverse effects are expected to Louisiana wildlife. Of course, standard precautions to avoid drift and runoff to waterways of the state are warranted. As stated on the Section 3 label, risk to managed bees and native pollinators from contact with pesticide spray or residues can be minimized when applications are made before 7 am or after 7 pm or when the temperature is below 55°F at the site of application.

Environmental Fate

Sulfoxaflor is a systemic insecticide which displays translaminar movement when applied to foliage. Movement of sulfoxaflor within the plant follows the direction of water transport within the plant (i.e., xylem mobile) as indicated by phosphor translocation studies in several plants. Sulfoxaflor is characterized by a water solubility ranging from 550 to 1,380 ppm. Sulfoxaflor has a low potential for volatilization from dry and wet surfaces (vapor pressure= 1.9×10^{-8} torr and Henry's Law constant= 1.2×10^{-11} atm m^3 $mole^{-1}$, respectively at 25 °C). Partitioning coefficient of sulfoxaflor from octanol to water (K_{ow} @ 20 C & pH 7= 6; Log K_{ow} = 0.802) suggests low potential for bioaccumulation. No fish bio concentration study was provided due to the low K_{ow}, but sulfoxaflor is not expected to bio accumulate in aquatic systems. Furthermore, sulfoxaflor is not expected to partition into the sediment due to low K_{oc} (7-74 mL/g).

Registrants tests indicate that hydrolysis, and both aqueous and soil photolysis are not expected to be important in sulfoxaflor dissipation in the natural environment. In a hydrolysis study, the parent was shown to be stable in acidic/neutral/alkaline sterilized aqueous buffered solutions (pH values of 5, 7 and 9). In addition, parent chemical as well as its major degradate, were shown to degrade relatively slowly by aqueous photolysis in sterile and natural pond water ($t^{½}$= 261 to >1,000 days). Furthermore, sulfoxaflor was stable to photolysis on soil surfaces. Sulfoxaflor is expected to biodegrade rapidly in aerobic soil (half-lives <1 day). Under aerobic aquatic conditions, biodegradation proceeded at a more moderate rate with half-lives ranging from 37 to 88 days. Under anaerobic soil conditions, the parent compound was metabolized with half-lives of 113 to 120 days while under anaerobic aquatic conditions the chemical was more persistent with half-lives of 103 to 382 days. In contrast to its short-lived parent, the major degradate is expected to be more persistent than its parent in aerobic/anaerobic aquatic systems and some aerobic soils. In other soils, less persistence is expected due to mineralization to CO_2 or the formation of other minor degradates.

In field studies, sulfoxaflor has shown similar vulnerability to aerobic bio-degradation in nine out of ten terrestrial field dissipation studies on bare-ground/cropped plots (half-lives were <2 days in nine cropped/bare soils in CA, FL, ND, ON and TX and was 8 days in one bare ground soil in TX). The chemical can be characterized by very high to high mobility (Kf_{oc} ranged from 11-72 mL g^{-1}). Rapid soil degradation is expected to limit chemical amounts that may potentially leach and contaminate ground water. Contamination of groundwater by sulfoxaflor will only be expected when excessive rain occurs within a short period (few days) of multiple applications in vulnerable sandy soils. Contamination of surface water by sulfoxaflor is expected to be mainly related to drift and very little due to run-off. This is because drifted sulfoxaflor that reaches aquatic systems is expected to persist while that reaching the soil system is expected to degrade quickly with slight chance for it to run-off.

When sulfoxaflor is applied foliar on growing crops it is intercepted by the crop canopy. Data presented above appear to indicate that sulfoxaflor enters the plant and is incorporated in the plant foliage with only limited degradation. It appears that this is the main source of the insecticide sulfoxaflor that would kill sap sucking insects. This is because washed-off sulfoxaflor, that reaches the soil system, is expected to degrade.

In summary, sulfoxaflor has a low potential for volatilization from dry and wet surfaces. This chemical is characterized by relatively higher water solubility. Partitioning coefficient of sulfoxaflor from octanol to water suggests low potential for bioaccumulation in aquatic organisms such as fish. Sulfoxaflor is resistant to hydrolysis and photolysis but transforms quickly in soils. In contrast, sulfoxaflor reaching aquatic systems by drift is expected to degrade rather slowly. Partitioning of sulfoxaflor to air is not expected to be important due to the low vapor pressure and Henry's Law constant for sulfoxaflor. Exposure in surface water results from the drifted parent compound, and only minor amounts are expected to run-off only when rainfall and/or irrigation immediately follow application. The use of this insecticide is not expected to adversely impact Louisiana ecosystems when used according to the Section 18 label. Of course, caution is needed to prevent exposure to water systems because of toxicity issues to aquatic invertebrates. As stated on the Section 3 label, this product should never be applied directly to water, to areas where surface water is present or to intertidal areas below the mean water mark. Also, the label includes the statement "Do not contaminate water when disposing of equipment rinsate."

Endangered and Threatened Species in Arkansas

No impacts are expected on endangered and threatened species by this very limited use of this insecticide as delineated in the Section 18 application. Sulfoxaflor demonstrates a very favorable ecotoxicity and fate profile as stated above and should not directly impact any protected mammal, fish, avian, or plant species. This product does adversely affect insects and aquatic invertebrates, especially bees, but the limited exposure to these species should not negatively affect endangered and threatened species in Arkansas when all applications label precautions are followed and preformed.

The above content in Section 166.20(a)(7): Discussion of Risk Information was, for the most part, prepared by Michael Hare, Ph.D. (Human Health Effects), David Villarreal, Ph.D. (Ecological Effects), and David Villarreal, Ph.D. (Environmental Fate), all with the Texas Department of Agriculture. The parts of the above content in this section, with references to Arkansas, were prepared by ASPB.

SECTION 166.20(a) 8: COORDINATION WITH OTHER AGENCIES IN ARKANSAS

The Arkansas State Plant Board will receive a copy of this request. Any comments received will be forwarded to the U.S. EPA.

SECTION 166.20(a) 9: NOTIFICATION/SUPPORT OF REGISTRANT

Dow AgroScience has been notified of this agency's intent regarding this application and has offered a letter of support (Attachment 4). They have also provided a copy of a label with the use directions for this use (although this use is dependent upon the approval of this section-18 by EPA) (Attachment 1).

SECTION 166.20(a) 10: ENFORCEMENT PROGRAM IN ARKANSAS

The Arkansas State Plant Board (ASPB) has adequate authorities for enforcing provisions of Section 18 emergency exemptions. ASPB will require Dow AgroScience to prepare Section 18 labeling that complies with ASPB and EPA requirements for this emergency use, if approved, to ensure that product distributed for the exemption is properly labeled.

SECTION 166.20(a) 11: REPEAT USES

This is the second request under a Section 18 of FIFRA, the product was used under a Section 18 in 2012. The product was labeled from 2013 through 2015 but the label was withdrawn for unknown or unspecified reasons. No valid reasons were given. We have had use of Transform since 2012 either through a Section 18 or a Label 3 and have no reported cases of problems with honey bees or pollinators in that time.

SECTION 166.20(b) 1: NAME OF THE PEST

Lygus lineolaris (Palisot de Beauvois), tarnished plant bug

SECTION 166.20(a) 11: DISCUSSION OF EVENTS OR CIRCUMSTANCES WHICH BROUGHT ABOUT THE EMERGENCY SITUATION

Prior to the mid-1990's, tarnished plant bugs were generally controlled by insecticides directed at other pests during the flowering period of cotton; therefore, economic damage from tarnished plant bugs during flowering was relatively uncommon. However, with >80% of Mid-South (Arkansas, Louisiana, Mississippi, Tennessee) cotton now being planted to transgenic cotton expressing one or more toxins derived from *Bacillus thuringiensis* (Bt) (Williams 2008) and the eradication of the boll weevil, *Anthonomus grandis grandis* Boheman (Coleoptera: Curculionidae), many of the foliar applications for other pests during flowering have been eliminated. An increase in federal conservation/wetlands reserve programs, wide scale adoption of conservation tillage systems, and increased diversity of the summer farmscape with crop rotations have created a more favorable environment enhancing tarnished plant bug population development. Recently, this region has experienced a significant reduction in cotton acres and subsequent increase in field corn which also has exacerbated this emergency situation. The tarnished plant bug has adapted to some grass crops with reproduction on field corn which provides a non-sprayed on-farm refuge for immigration to "fewer" cotton acres; thereby concentrating the population. The consequence of these Southern production system changes is that tarnished plant bug has become the dominant season-long pest across this region during the last decade. Just due to higher populations which persist longer during the season, control costs and crop losses associated with tarnished plant bugs have increased dramatically. Typically, fewer than two applications per season were directed towards this pest prior to the mid-1990's. Now as of last year growers made an average of 5 insecticide applications targeted at this pest in in Arkansas (Williams 2011).

In addition, an increase in the frequency of chemical control strategies for this pest has intensified selection for resistance. Snodgrass and Gore (2007) has reported resistance to a number of OP's, carbamates, and pyrethroids. Producers were relying heavily on neonicotinoids (thiamethoxam, imidacloprid), but now some populations are expressing reduced sensitivity to those products. In addition, the actual seasonal AI/acre of neonicotinoids further restricts product availability. In order to obtain some level of population management, there has been an increase in rates to the highest dose labeled for a single application. Tarnished plant bug management in many Mid-South fields has degraded to a point where the only option to reduce yield impacts is co-application of products with different modes of action. As referenced by Luckmann and Metcalf (1982) on the stages of crop protection, cotton producers and pest management practitioners are in crisis phase with tarnished plant bug. The subsequent step is that of the disaster phase which would result in a collapse of the existing pest management system for Mid-South cotton. As mentioned, there has not been a single documented case of bee loss in cotton with 4 years of use with sulfoxaflor in any region of Arkansas.

SECTION 166.20(a) 11: DISCUSSION OF ANTICIPATED RISKS TO ENDANGERED OR THREATENED SPECIES, BENEFICIAL ORGANISMS, OR THE ENVIRONMENT REMEDIED BY PROPOSED USE

As previously stated, it is not anticipated that there should be any risk to endangered or threatened species, beneficial organisms, or the environment if all applications are made in accordance to the section 18 use directions.

- See Attachment 5 – Endangered and Threatened Species List 2014

SECTION 166.20(a) 11: DISCUSSION OF SIGNIFICANT ECONOMIC LOSS

TIER 1 ANANLYSIS

In a review of pest significance by regions, the tarnished plant bug has had the most severe impact on Mid-South cotton during the past 5 years. In these areas, specifically in the delta regions of Arkansas, Louisiana, and Mississippi, it has been ranked the number one most yield limiting pest over the last several years (Williams 2008-2015). In 2007, control cost for tarnished plant bug in the Mid-South was at least three-fold greater than the national average control cost. In a comparison of recent years it is obvious

Tables 7 and 8 show a comparison of yields from the emergency period (Pre Transform) and the non-emergency period (Post Transform) for the state of Arkansas. Since Transform became available it is clear that yields have increased (17.1%) and overall plant bug applications have increased (94%). This information supports the criteria for emergency exemption under Tier 1 analysis for the state of MS.

Table 7. Arkansas Losses due to Tarnished Plant Bug by Year

Year	Cotton acreage	% acreage treated for TPB	Average no. applications targeting TPB	Average cost ($) per treatment	Average total cost ($/acre)	Average % yield loss	Average yield (pounds per acre)
Prior to introduction of sulfoxaflor							
2008	640,000[1]	84[2]	1.88[2]	$6.75[2]	$12.69[2]	1.44%[2]	1,012[1]
2009	520,000	90	2.88	$7.01	$20.18	2.79%	818
2010	537,000	92	2.80	$6.45	$18.06	2.74%	1,045
2011	620,000	100	4.35	$7.01	$30.48	3.42%	929
Averages	**579,250**	**91.5%**	**2.98**	**$6.81**	**$20.35**	**2.60%**	**951**
Post introduction of sulfoxaflor							
2012	580,000	99	5.13	$9.00	$46.18	4.00%	1,064
2013	318,000	100	6.00	$9.00	$54.00	5.00%	1,133
2014	316,000	100	6.00	$7.00	$42.00	3.83%	1,145
2015	205,000	100	6.00	$7.34	$44.06	3.92%	1,112
Averages	**354,750**	**99.8%**	**5.78**	**$8.09**	**$46.56**	**4.19%**	**1,114**
Percent change (pre-sulfoxaflor vs. post sulfoxaflor)							
	-38%	**9.1%**	**94%**	**18.8%**	**128%**	**61.2%**	**17.1%**

[1]Average yields based on NASS survey data for Arkansas, http://www.nass.usda.gov/Statistics_by_State/Arkansas/index.php
[2]Application costs based on Mississippi State University Beltwide Cotton Losses archive, http://www.entomology.msstate.edu/resources/cottoncrop.asp

Table 8. Analysis of yield, cost and revenues for Arkansas.

	Yield (pounds lint/acre)	Costs ($/acre) of TPB applications	Gross revenue ($/acre)	Net revenue ($/acre) after TPB costs
Prior to introduction of sulfoxaflor				
2008	1,012[1]	$12.69[2]	$627.44[3]	$614.75
2009	818	$20.18	$507.16	$486.98
2010	1,045	$18.06	$647.90	$629.84
2011	929	$30.48	$575.98	$545.50
Avg 2008-2011	951	$20.35	$589.62	$569.27
Post introduction of sulfoxaflor				
2012	1,064	$46.18	$659.68	$613.50
2013	1,133	$54.00	$702.46	$648.46
2014	1,145	$42.00	$709.90	$667.90
2015	1,112	$44.06	$689.44	$645.38
Avg 2012-2015	1,113	$46.56	$690.37	$643.81
Percent change (pre-sulfoxaflor vs. post-sulfoxaflor)				
Change 2012-2015	162	$26.21	$70.06	$74.54
	17.1%	128.8%	17.1%	13.1%

[1]Average yields based on NASS survey data for Arkansas, http://www.nass.usda.gov/Statistics_by_State/Arkansas/index.php
[2]Application costs based on Mississippi State University Beltwide Cotton Losses archive, http://www.entomology.msstate.edu/resources/cottoncrop.asp
[3]Gross revenue assuming an average cotton price of $0.62 per pound of lint

Table 9. Yield loss associated with Transform compared to commercial standards and untreated check in efficacy trial,2015.

Treatment	**Season Total Plant Bugs**	**Yield pounds/acre**	**% below**
Transform 1.75 oz.	45	4157	
UTC	140	3244.1	-22%
Strafer 3 oz.	61	3307.2	-20%
Centric 2 oz.	75	3387.4	-19%
Centric 2 oz. & Diamond 6 oz.	65	3426.1	-18%
Orthene 1 lb.	46	3335.8	-20%

Table 10. Yield loss associated with Transform compared to commercial standards and untreated check in efficacy trial,2014

Treatment	Season Total Plant Bugs	Yield lbs./acre	% below
Transform 1.75 oz.	19	5326.6	
UTC	149	2499	-53
Bidrin 6 oz./acre*	38	4237.9	-20
Brigade 5.6 oz./acre*	70.4	3598	-32
Sivanto 14 oz./acre	85	2804.8	-47
Vydate C-LV 10.7 oz./acre	51	3151.8	-41
DoubleTake 4 oz./acre	143	2473.8	-54

SUMMARY OF ANALYSIS

Tarnished plant bug is a pest that is not a restricted problem on local acreage. During the past 4 years, this pest infested virtually 100% of the planted acreage in Arkansas (Table 7). Direct losses from this pest in Arkansas indicate an average of 4.19% yield loss in spite of spending an average $46.56/acre per year for control. This should be considered a conservative estimate because currently there is no alternative strategy which can be used to eliminate crop damage and cotton yield losses from tarnished plant bug. Based on the average for the last 4 years Arkansas's historical insect losses and yield data, producers spent over $16.5MM with an estimated cost of control and yield loss of $34.8MM. These data are outlined in the chart/Excel file below and published on the website: http://www.entomology.msstate.edu/resources/tips/cotton-losses/ data. However, as shown in Table 8, cotton acreage was reduced by 38%, the percentage of acreage treated increased dramatically and the number of applications has almost doubled. The average cost of control has increased and the total cost of control for plant bugs has more than doubled. While yields have increased they certainly have not kept up with the cost of control and associated loss from tarnished plant bug.

Two studies, one in 2014 and one in 2015 clearly show the level of control and impact on yield that Transform has compared to other standard insecticides (Tables 9 &10). A 20 to 32% yield loss for all standards compared to Transform. The above referenced information on the analysis required by EPA for emergency exemption clearly demonstrates that all criteria are met for sulfoxaflor in the state of Arkansas. These data also demonstrate that since Transform has become available for use in cotton, Arkansas producers have benefited greatly both in terms of gross revenue and increased yield protection. Furthermore, during the 4 year period that Transform has been used, there have been no reports of bee kills associated with this product and our largest commercial bee keepers support the Section 18 for Transform (Attachments 2 & 3). Additionally many growers in regions with only moderate resistance levels have also benefitted from the safety toward beneficial insect populations in the field. Overall, Transform has become one of the foundation products in our IPM cotton program.

(ii) The information in paragraph (b) (4) (i) of this section plus prices reasonably anticipated in the absence of the emergency and changes in prices and/or production costs due to the emergency;

The trends previously described (Section b4i) clearly show the recent (5 years) significance of the problem and magnitude of costs and yield losses associated with tarnished plant bugs in cotton.

(iii) The information in paragraph (b) (4) (ii) of this section plus operating costs reasonably anticipated in the absence of the emergency;

The trends previously described (Section b4i) clearly show the recent (5 years) significance of the problem and magnitude of costs and yield losses associated with tarnished plant bugs in cotton.

(iv) Any other information explaining the economic consequences of the emergency.

The absence of new products to manage tarnished plant bug has seriously impaired the economic viability of cotton across Arkansas and the rest of the Mid-South region. Use of the available products in the recommended chemical control strategy is not economically feasible, sustainable, or environmentally friendly. During the anticipated conditional Section 18 registration period (2011), sulfoxaflor has the potential to mitigate the substantial financial losses, and become part of a holistic IPM program for cotton growers.

Summary:

<u>The Current Situation Producers are Facing in Cotton Producing Areas in Arkansas</u>

The 2014 and 2015 season resulted in even higher pressure from tarnished plant bug resulting in another increase in the average number of applications required to attempt an acceptable level of control for tarnished plant bug. Cost of control went from over $30 per acre to about $43 per acre the last two years. No other pest comes close to the loss associated with this pest. Unlike Mississippi that has easily defined areas like the Hills vs Delta, in Arkansas we have only Delta and within the Delta are areas where plant bugs are not as much of an issue and others where plant bugs are very bad, this is confounded by the fact that both types of areas can and do occur in the same county or area. We need every tool we can get to manage this tarnished plant bug issue, at the same time we do not want to cause harm to the environment. However, there is no threat with sulfoxaflor. Tarnished plant bug represents a real threat to the producers in the Midsouth. I would much rather have two or three applications of sulfoxaflor than four or five of an organophosphate.

Sulfoxaflor (Transform) has been used by producers in Arkansas and the Midsouth since 2012 in cotton for control of tarnished plant bugs. Since its introduction, Transform has reduced overall tarnished plant bug applications and provided significant yield increases and returns in gross revenues. Transform is considered a foundational product in Arkansas and the Midsouth cotton IPM programs in cotton due to its safety on beneficial insects. Since 2013, Transform has been used on more than three million acres across the mid-south region with zero reported incidents of adverse effects on bees or other pollinators. Furthermore, studies by Whalen et al. (2015) indicate that in mid-south agroecosystems cotton is not a preferred foraging host.

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